How did Chatham Island get its funny shape?

Looking S with Red Bluff and the southern massif skyline, Chatham Island
Red Bluff Tuff Fm (Eocene, 55-50 Ma)

Hamish Campbell
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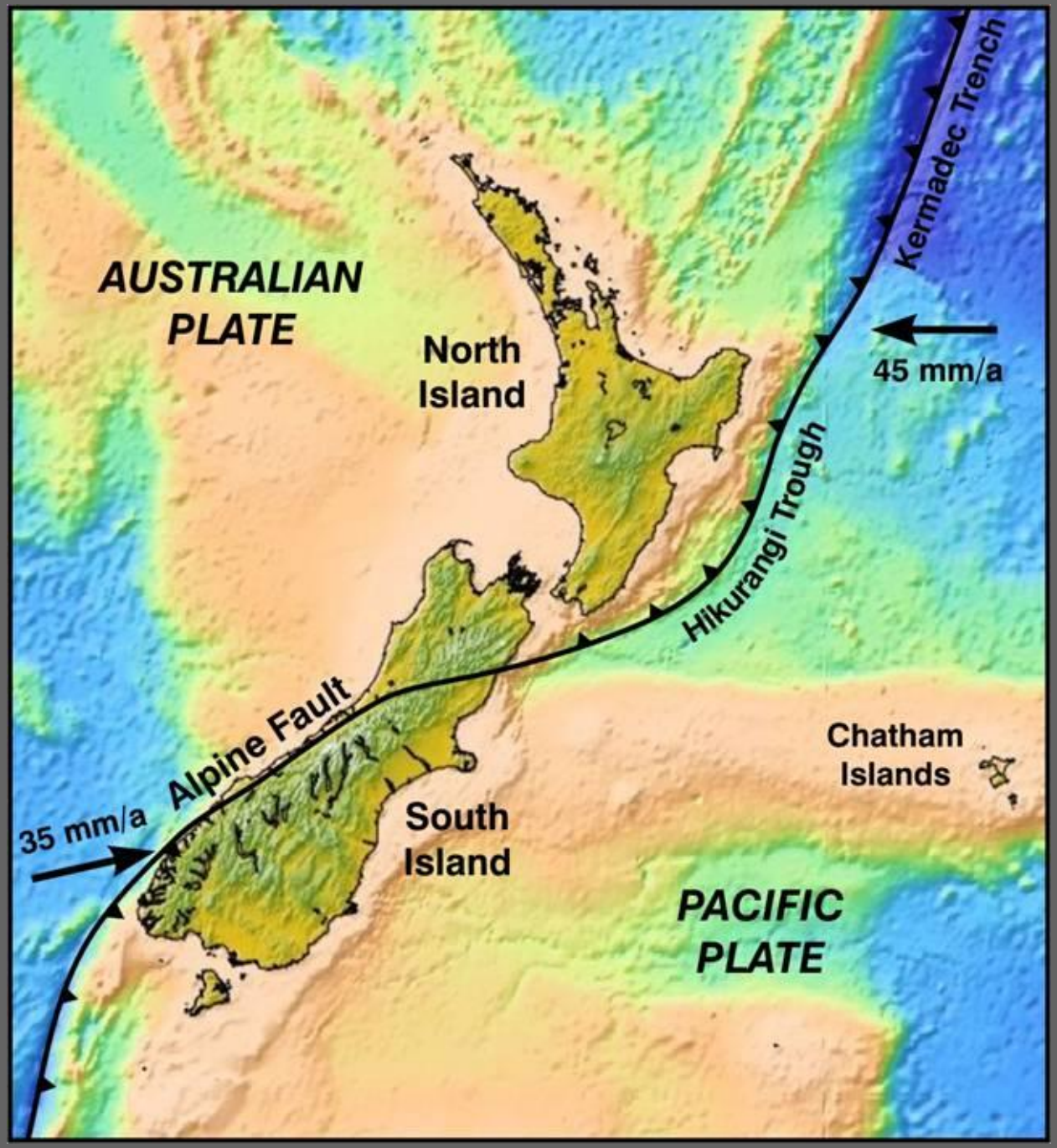

AUSTRALIAN
PLATE
North
Island
Kermadec Trench
45 mm/a
Hikurangi Trough
Alpine Fault
35 mm/a
South
Island
Chatham
Islands
PACIFIC
PLATE

CHATHAM ISLANDS (NASA)

N-S dimension of Chatham = 50 km

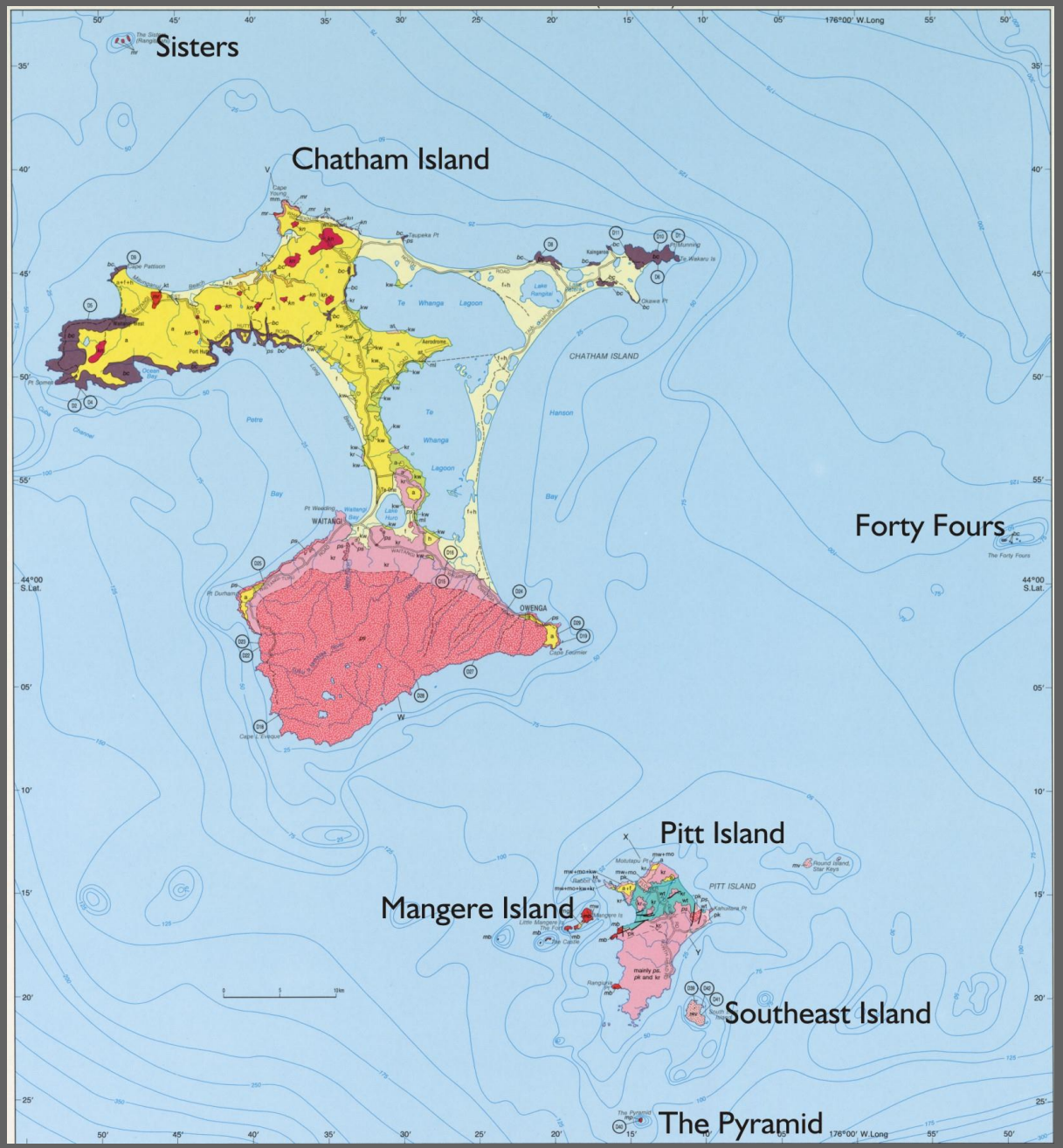
E-W dimension of Chatham= 65 km

GEOLOGY OF THE CHATHAM ISLANDS

Chatham Islands (3-0 Ma)
Sands, soils, peat (yellows)

Zealandia (85-3 Ma)
Marine sediments (pale green)
Submarine basalt (red)
Red Bluff Tuff Fm (pink)
Terrestrial basalt (stipled red)

Gondwana (250-85 Ma)
Tupuangi Fm (green)
Schist (purple)



Point Weeding, near Waitangi, Chatham Island
Red Bluff Tuff Fm; Eocene palagonite (55-50 Ma)

Red Bluff Tuff at Point Weeding, near Waitangi
Eocene palagonite (55-50 Ma)

WHAT IS VOLCANIC ASH?

Mt Ruapehu eruption
1995-1996

Soap bubble analogy for an exploding bubble of volcanic glass

Cape Young, N Chatham, looking E towards Mt Chudleigh
Red Bluff Tuff Fm (Eocene, 55-50 Ma)

Waihere Bay, W coast of Pitt Island
Red Bluff Tuff Fm (Eocene marine volcanic sediments, 55-50 Ma) overlying grey Tupuangi Fm (Cretaceous fluvial sands and silts, 95-90 Ma)

Tupuangi Formation; Waihere Bay, E coast of Pitt Island
Oldest sedimentary rock formation in the Chathams
Only exposed on Pitt and Mangere islands
Cretaceous (95-90 Ma) fluvial (river) sediments: sands, silts, gravels

Mount Dieffenbach, NW Chatham Island

The Horns, Cape Cap l'Eveque, SW Chatham Island
A submarine volcanic cone overlying older lava flows of Chatham Volcano

Photo taken from *Spirit of Enderby,* March 2021

The Horns, Cape Cap l'Eveque, SW Chatham; looking to the W
Red Bluff Tuff overlying basalt lava flows of Chatham Volcano

The Pyramid: youngest volcano in the Chatham Islands (2.7 Ma)

Photo taken from *Heritage Adventurer* ,Dec 2022

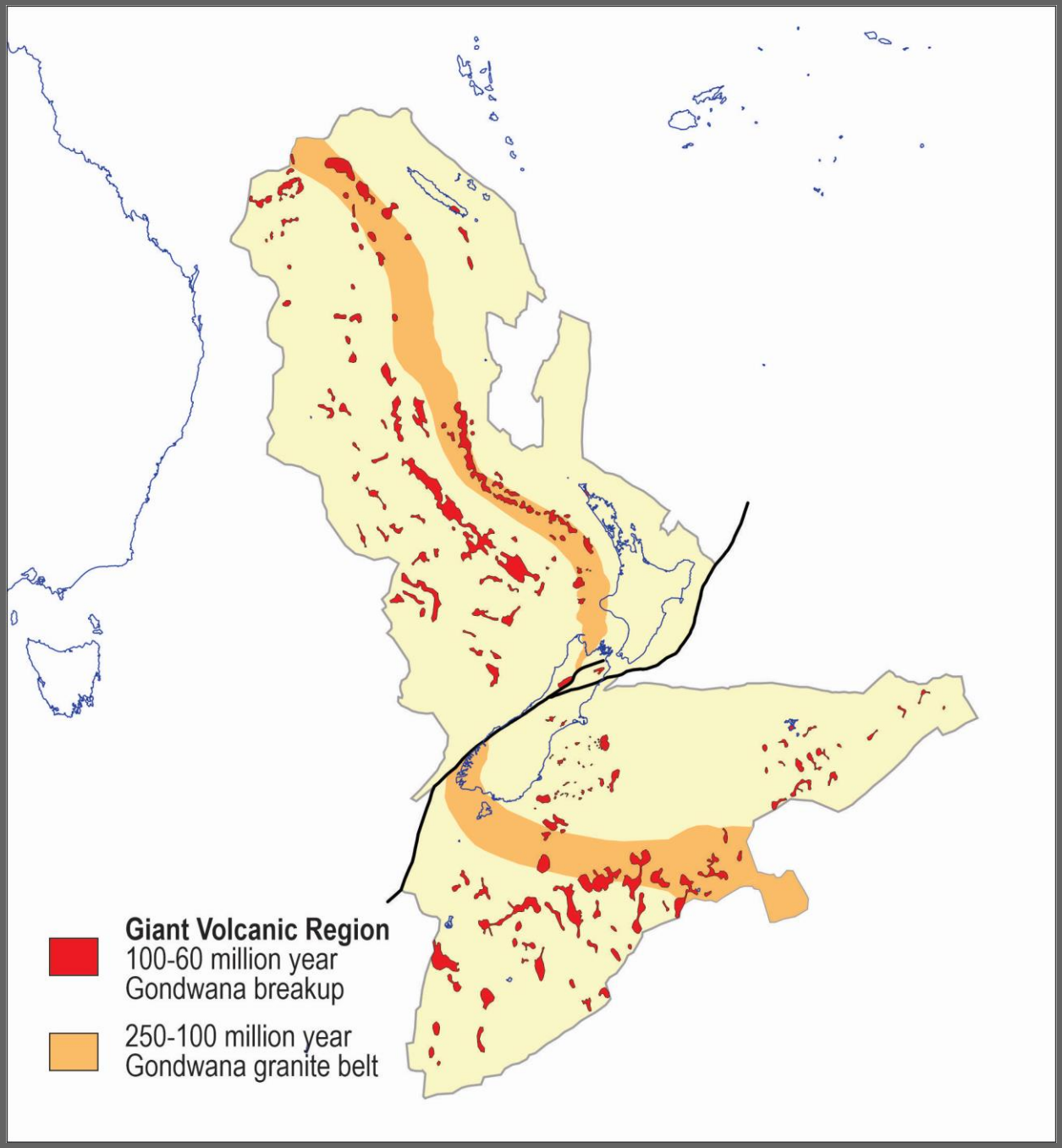
Volcanic cones, NW Chatham
Northern Volcanics Fm (65-8 Ma) and Rangitihi Volcanics Fm (5 Ma)
All erupted submarine

ZEALANDIA

Giant Volcanic Region

Mortimer et al. (2023): Reconnaissance basement geology and tectonics of North Zealandia. *Tectonics*

Zealandia-wide evidence of ‘leaky crust’…as in the Chathams and Auckland



Chatham Island, looking W along the south coast
Southern Volcanics Fm: lava flows of Chatham Volcano

The Forty Fours / Motuhara, looking N. About 50 km E of Chatham Island

Photo taken from *Spirit of Enderby*, March 2021

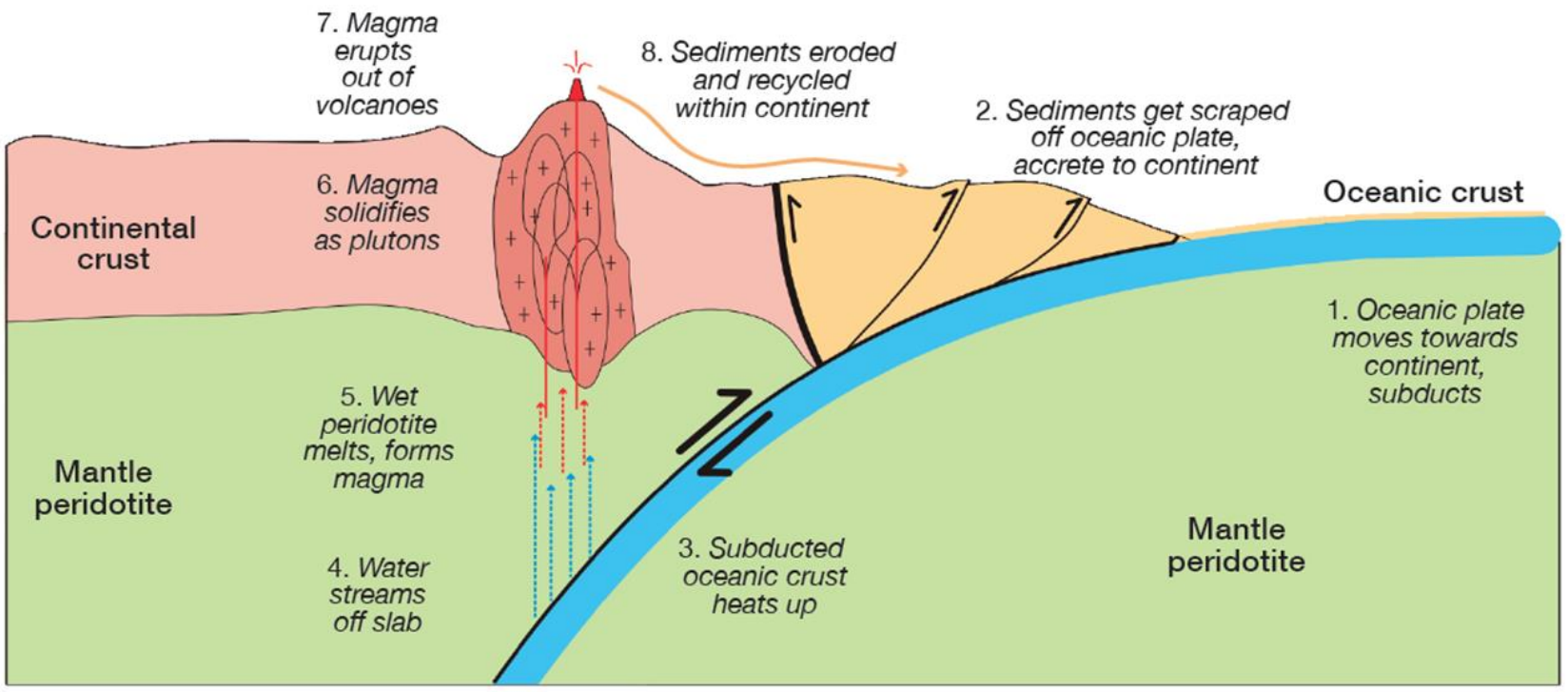
Chatham Schist at The Forty Fours / Motuhara

The *Tessa B*, a Giant Petrel and Peter Johnson for scale; 2004.

Chatham Schist
Looking W from a S-facing coast E of the Basalt Columns, N Chatham Island

Chatham Schist with abundant quartz veins; at Point Munning, NE Chatham

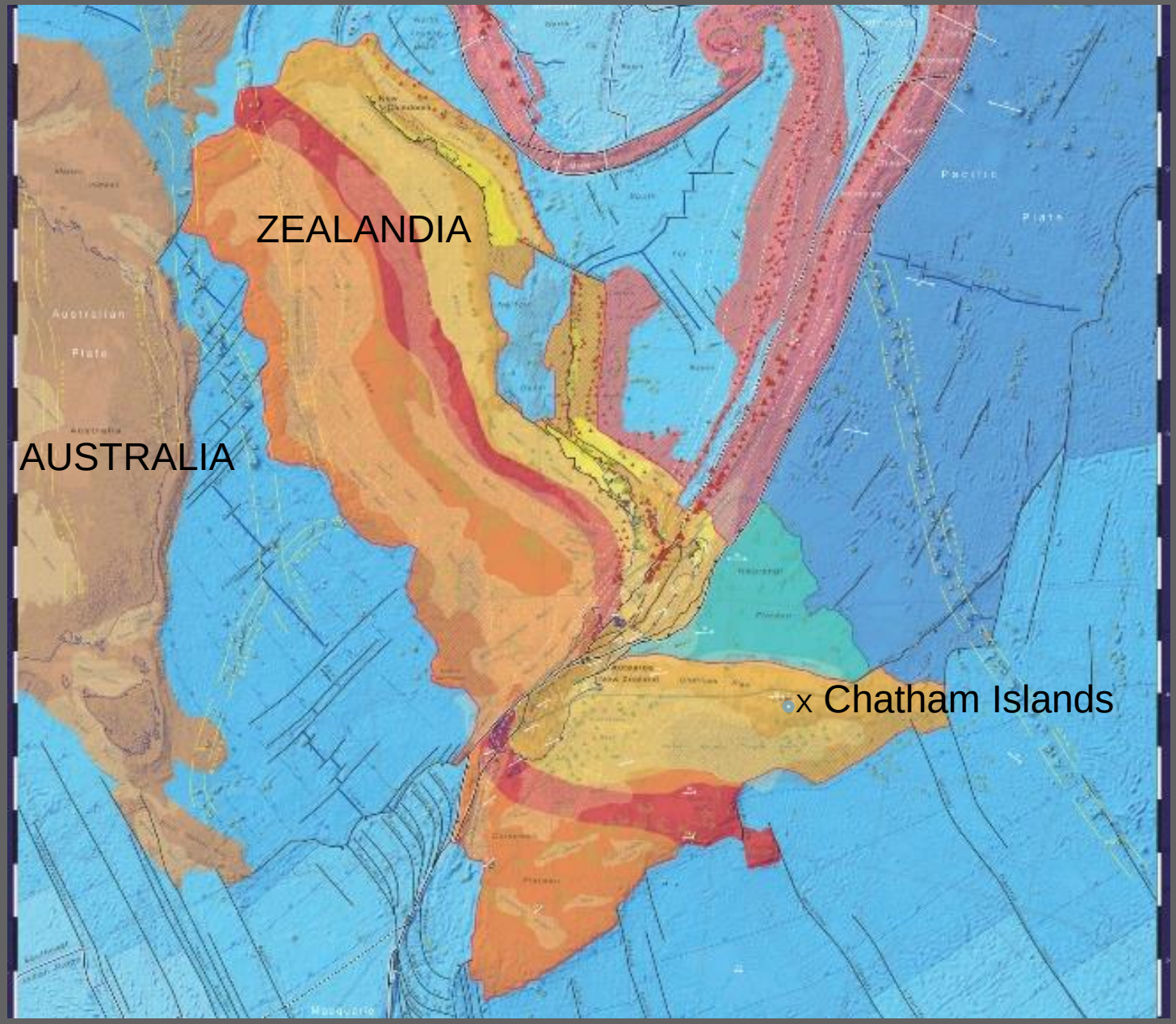
The Subduction Factory



TECTONIC MAP OF ZEALANDIA

Mortimer, Smith Lyttle & Black (2020)
GNS Science Map Poster 8

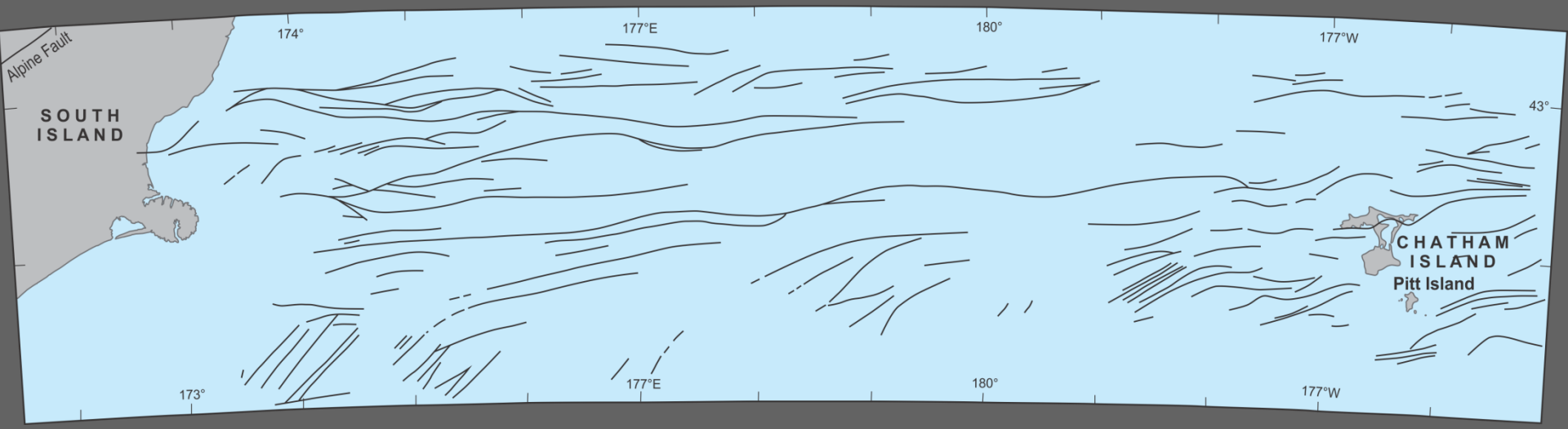
- Lambert projection
- Seamless colour & shading ramps
- 1:8.5 million (scale)




GONDWANA
90 Ma
Papua New Guinea
Line of main split of
Gondwanaland-Zealandia
New Caledonia
Zealandia
Australia
Chatham
Rise
East Antarctica
West
Antarctica

FAULTS WITHIN BASEMENT ROCKS OF THE CHATHAM RISE

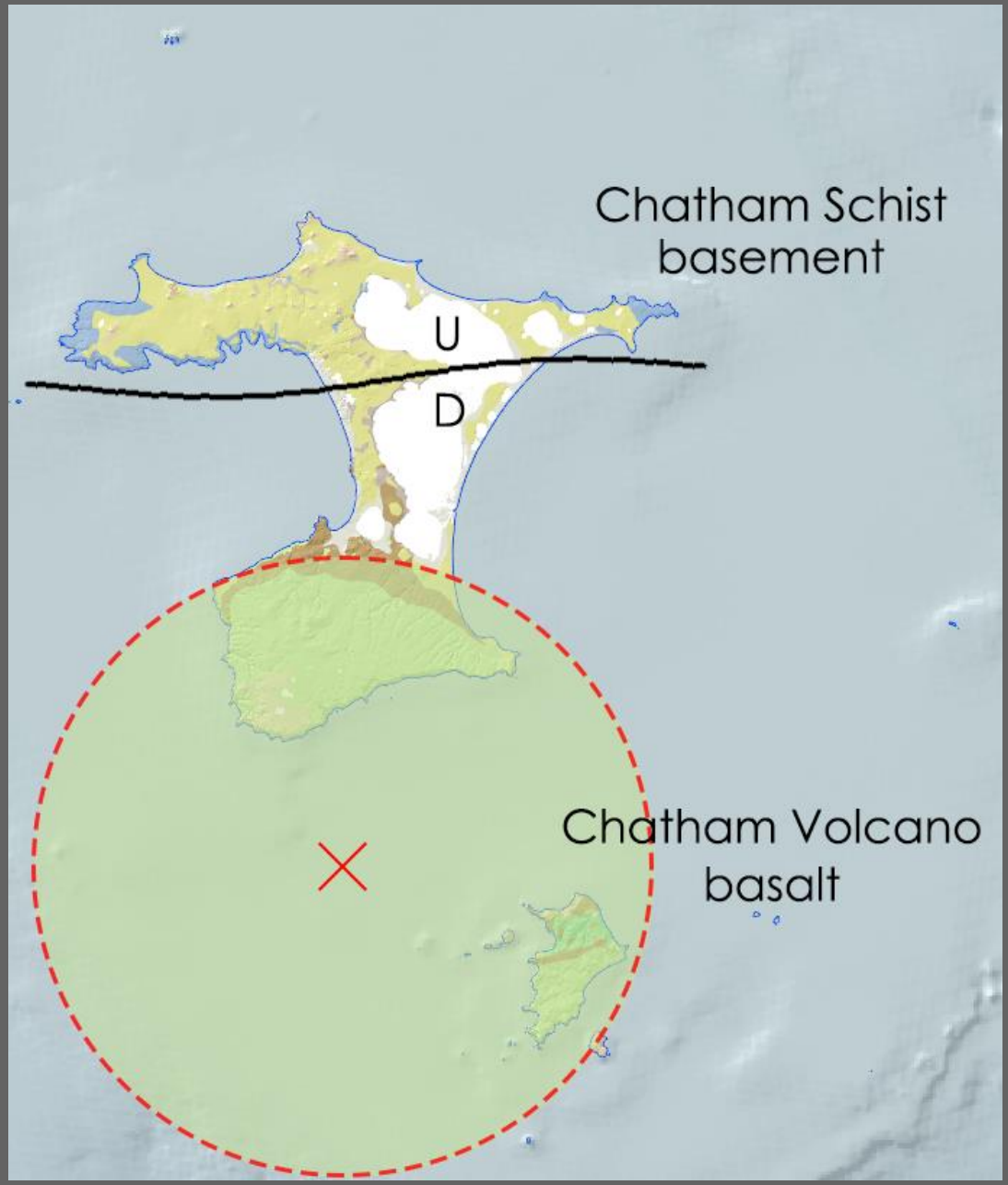
Wood, Andrews & Herzer (1989): *NZGS Basin Studies 3: Chatham Rise, Map 4*



CHATHAM VOLCANO

A shield volcano
85 – 80 Ma

Southern Volcanics Fm
(Cretaceous)



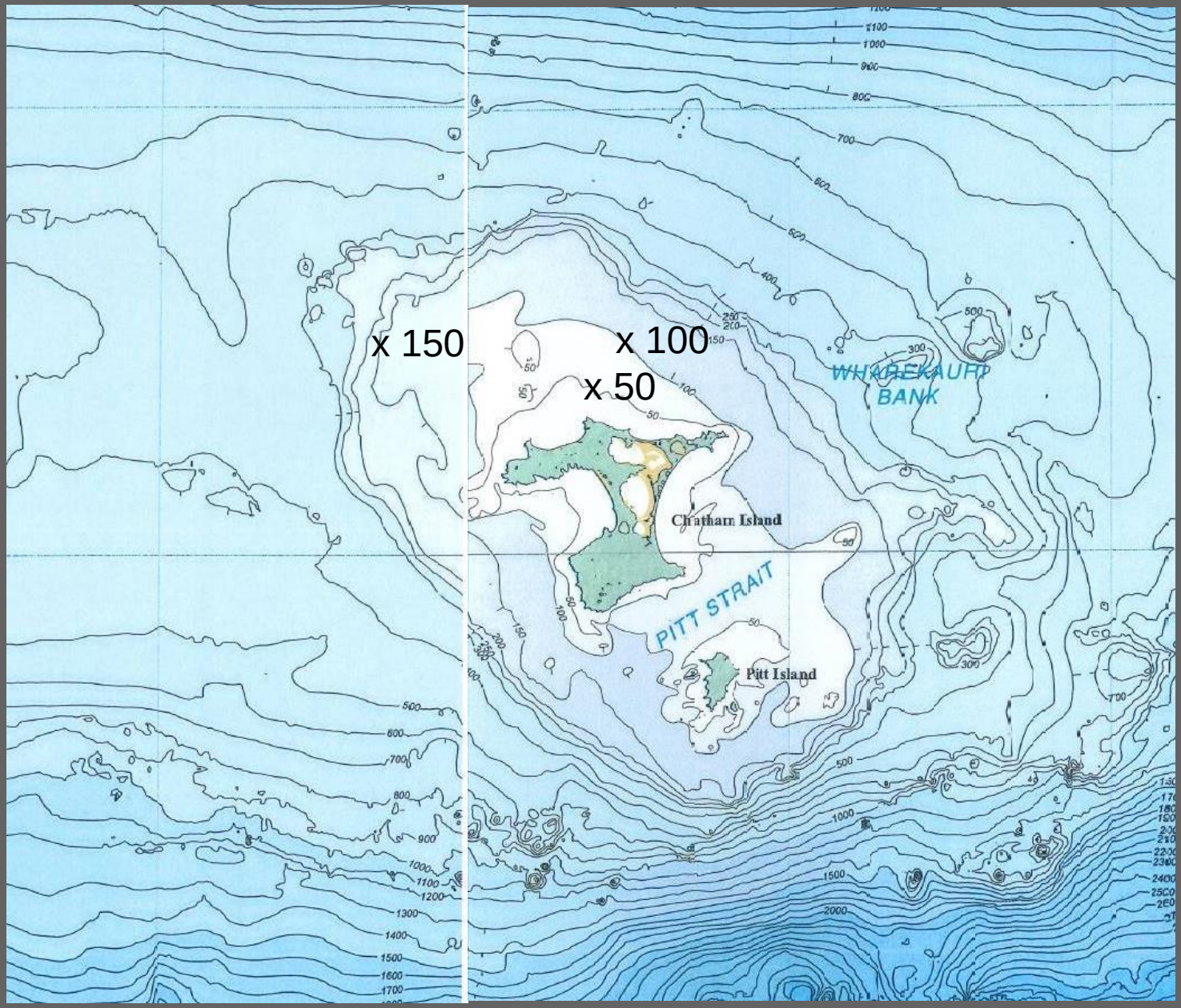
BATHYMETRY OF THE CHATHAM RISE (NIWA 2005)

Chatham Islands area = 800 sq km

20,000 years ago sea-level was 125 m below present

Land area would have been about 4 times larger

50, 100 and 150 m isobaths are shown



Tioriori, NW Chatham
Looking W towards Maunganui
Tioriori Group, Paleocene-Eocene (65-50 Ma)
Soft marine authigenic and biogenic sediments
Takatika Grit, Tutuiri Greensand Tumaio Limestone

Tioriori Group exposed near Tioriori, N Chatham Island; Tutuiri Greensands overlying Takatika Grit (deep marine authigenic and biogenic sediments)

PREFERENTIAL EROSION….

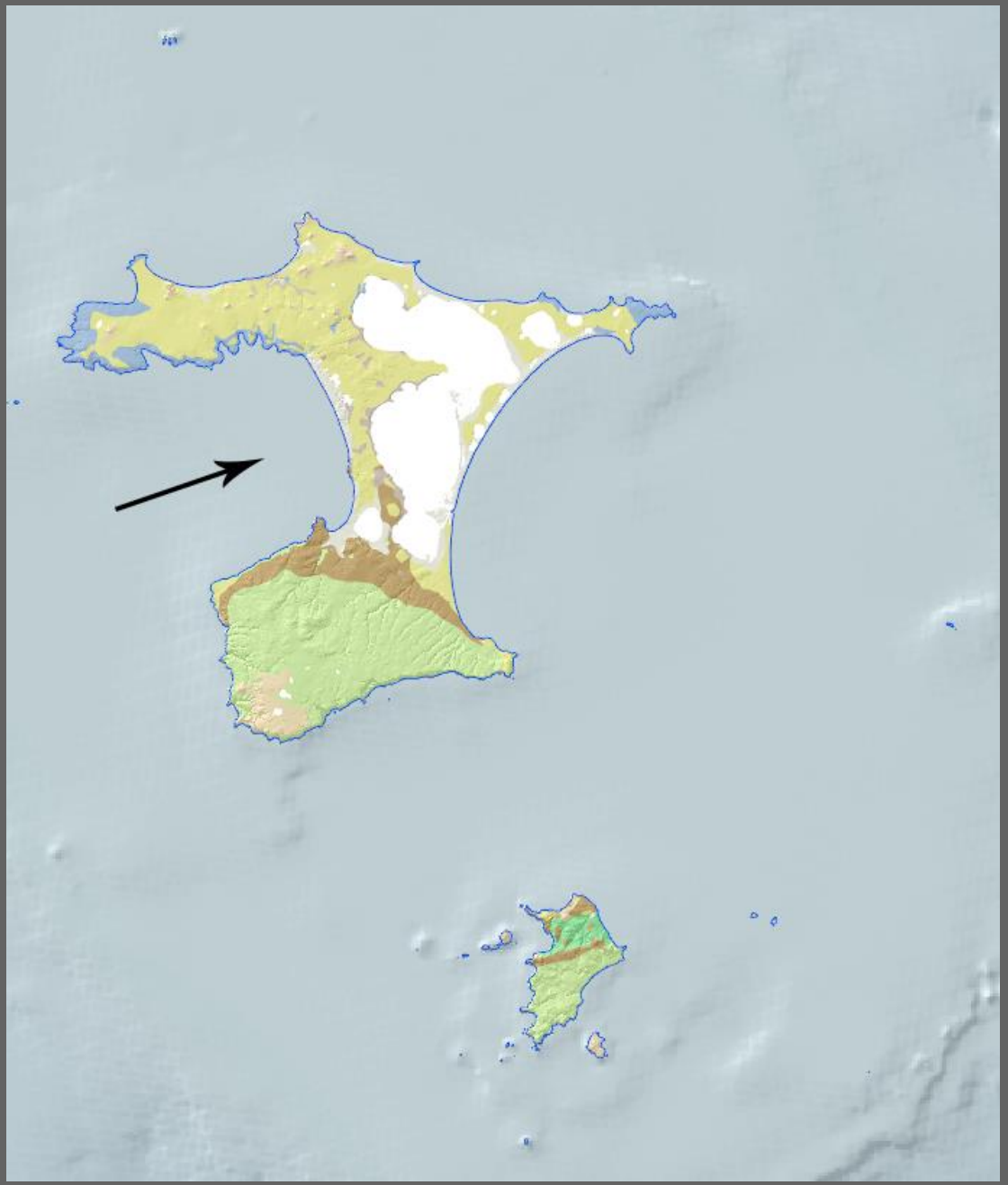
BY THE SOUTHWEST WIND

Hard versus soft

Hard rock = basalt, schist

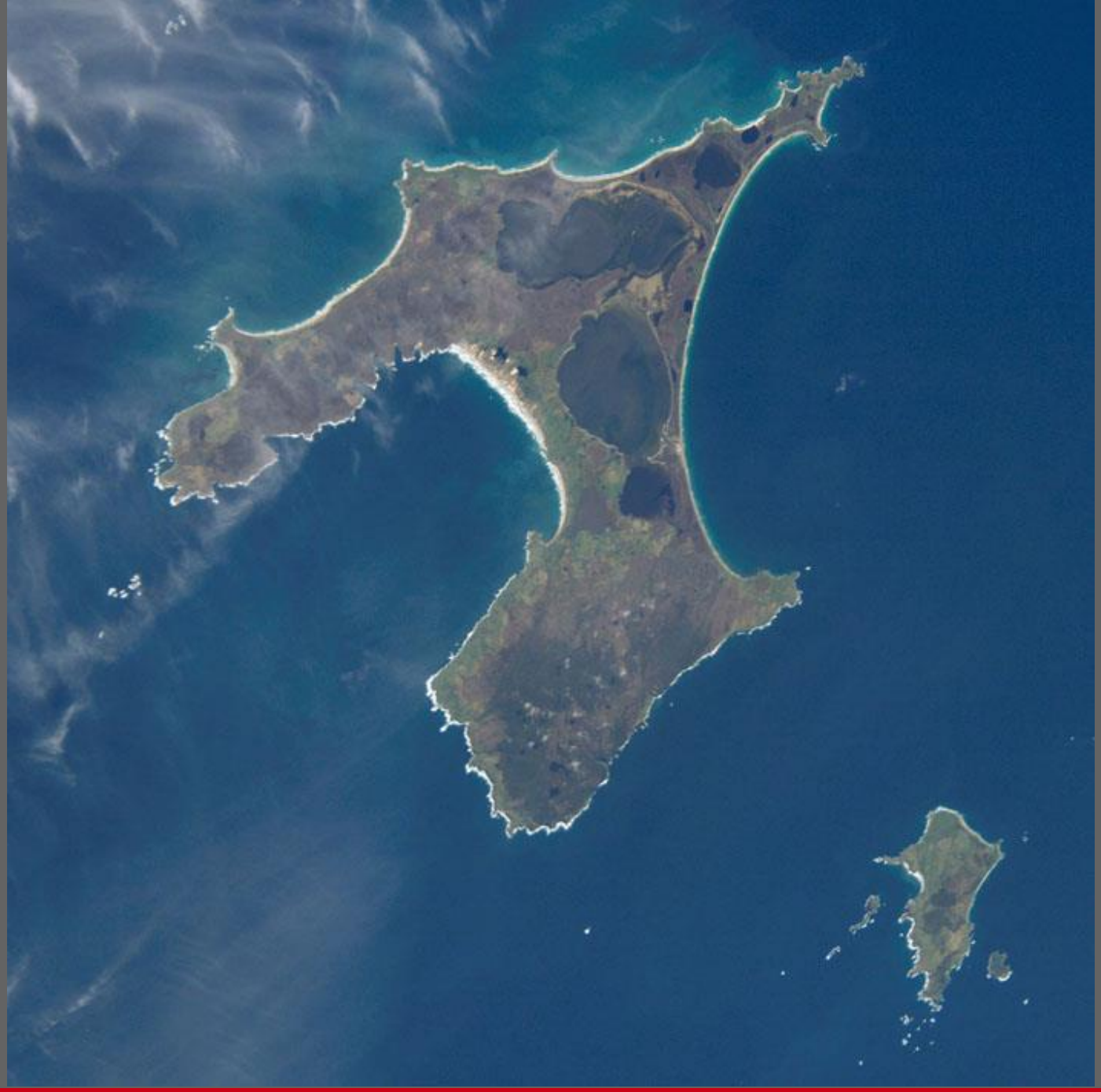
Soft sediment = sandstone, limestone, sand

In between = tuff, peat



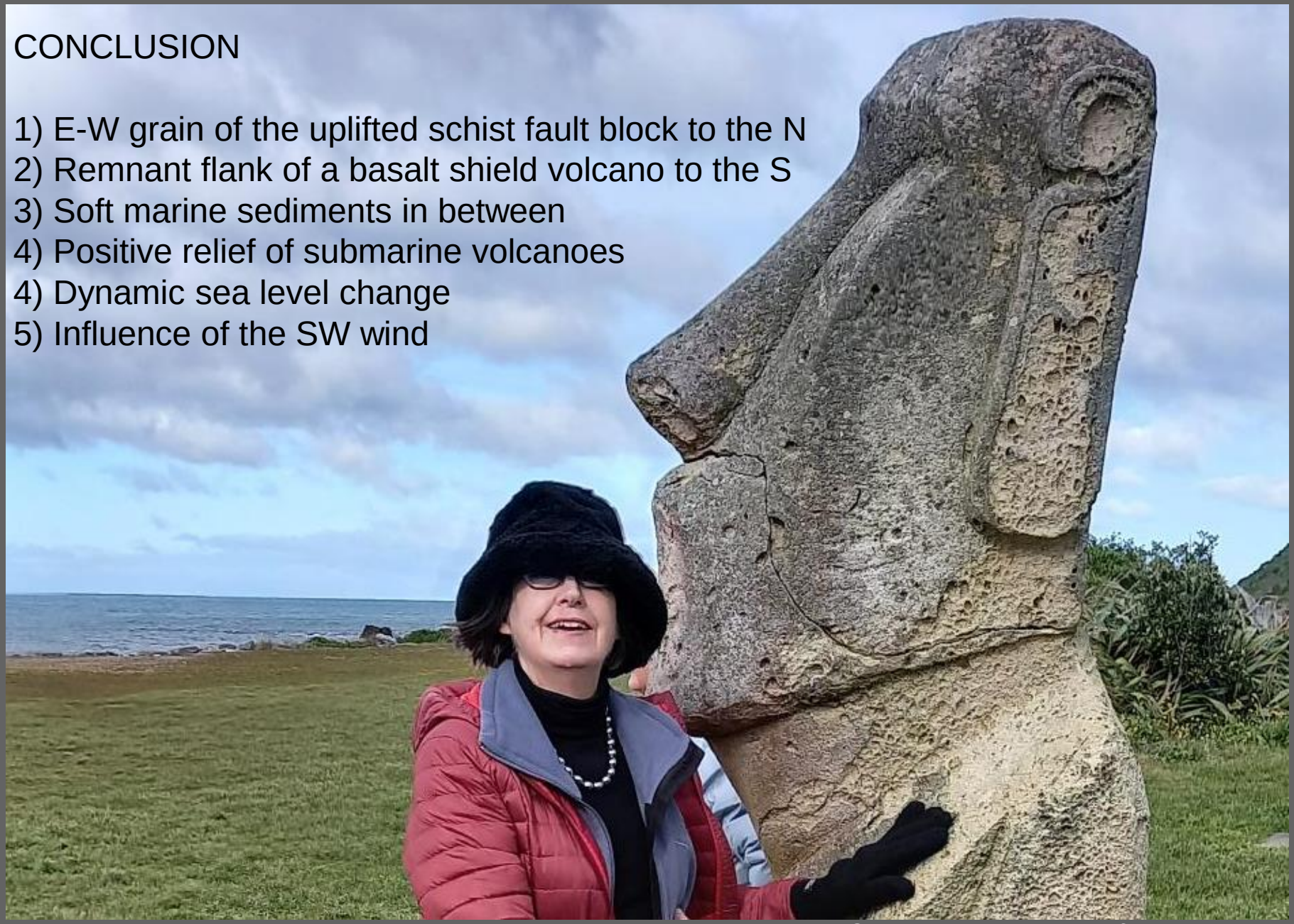
Te Whanga Limestone (Eocene; 55-35 Ma), S end of Red Bluff
'Contemplation Bay'
Facing a sou'wester

Te Whanga Lagoon with ‘standing waves’ of sediment
On the move from SW to NE



CONCLUSION

1) E-W grain of the uplifted schist fault block to the N
2) Remnant flank of a basalt shield volcano to the S
3) Soft marine sediments in between
4) Positive relief of submarine volcanoes
4) Dynamic sea level change
5) Influence of the SW wind



Sue Dale on location with Moai, Lyall Bay, Wellington, Sat 12 Aug 202, *Geological Highlights of Wellington'*
Moai carved from Hinuera Stone = Ongatiti Ignimbrite, 1.3 Ma; erupted from Mangakino Caldera, TVZ

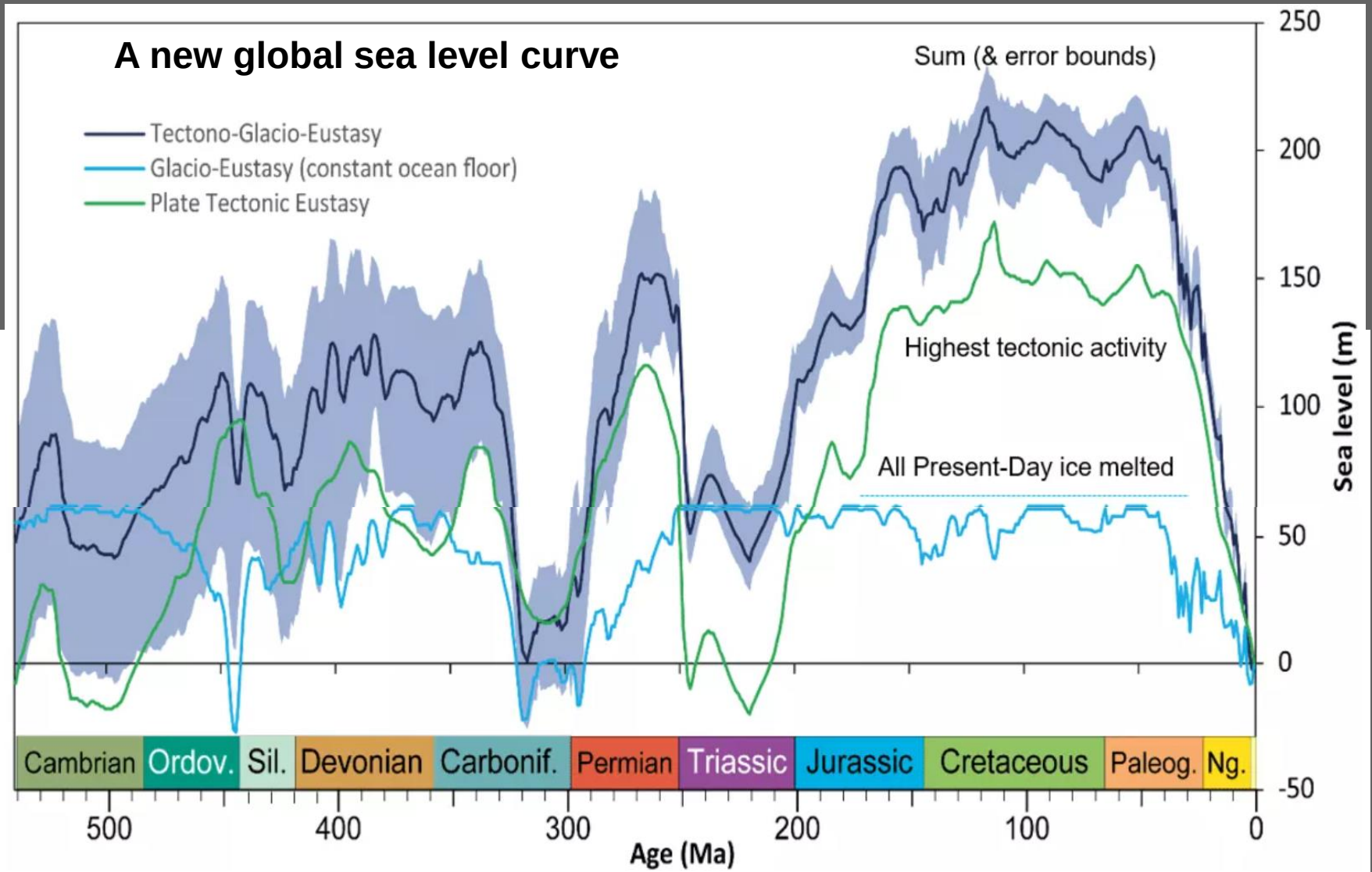


Figure 1. Isostatically compensated effects of plate tectonics, glaciations (>1Myr) and the combined Tectono-Glacio-Eustatic curve including RMS uncertainty ranges (shaded blue). Modified from van der Meer et al. (2022).

Scotese, C. R. et al. 2021: Phanerozoic paleotemperatures. *Earth-Science Reviews.*
Van der Meer, D. G., et al. 2022: Long term Phanerozoic global mean sea level. *Gondwana Research*.